

TEACHERS' POSITIONING OF STUDENTS IN RELATION TO ABILITY/ACHIEVEMENT IN A PROFESSIONAL DEVELOPMENT SETTING

Marrielle Myers
N.C. State University
mmyers2@ncsu.edu

Cynthia Edgington
N.C. State University
cpedging@ncsu.edu

P. Holt Wilson
UNC-Greensboro
phwilson@uncg.edu

Paola Sztajn
N.C. State
University
psztajn@ncsu.edu

This paper reports on elementary teachers' positioning of students as learners of mathematics related to their perceived ability level or previous achievement in mathematics. This work, which is a part of a larger design experiment on teacher learning of mathematics learning trajectories, examines the ways in which LTs influenced teachers' positioning of students and the changes we observed in teachers' discourse as teachers engaged in various professional learning tasks throughout the professional development.

Keywords: Teacher Beliefs, Learning Trajectories, Teacher Education-Inservice/Professional Development

Research has demonstrated that professional development providing teachers with opportunities to examine students' mathematical thinking can lead to productive changes in teachers' mathematical knowledge and classroom practices (Franke, Carpenter, Levi, & Fennema, 2001; Kazemi & Franke, 2004; Sowder, 2007). These experiences promote teacher learning by providing teachers with specific knowledge of students' strategies and bringing attention to students' underlying conceptions (Little, 1999). Moreover, using student work as a tool for professional development can assist teachers in shifting from focusing on students' mistakes to attending to the processes students are using and levels of sophistication in students' reasoning (Kazemi & Franke, 2004).

In this paper, we focus on a professional development project that uses student thinking in the form of learning trajectories (LTs). Researchers developing LTs use clinical interviews with students to empirically develop and refine pathways of student knowledge in particular content domains that progress from less sophisticated to more sophisticated (Clements & Sarama, 2004; Confrey et al., 2009). The emerging research on teachers' uses of LTs suggests that trajectories can support them in attending to student thinking during task selection, classroom interactions, and in assessing students' knowledge (Sztajn, Confrey, Wilson, & Edgington, 2012). Our work uses design experiment methodology to examine teacher learning of LTs to allow for the study of the processes of change in teachers' discourse about students' mathematical thinking. In particular, we are interested in the ways teachers talk about students' successes and failures in mathematics as they position themselves and their students within their professional community.

We begin this paper by briefly reviewing teacher learning of students' mathematical thinking and presenting our research question. We describe the context of the professional development and research methods. We share findings with respect to one particular aspect of teachers' discourse related to students' achievement and ability and conclude with a discussion of the role of LTs in teachers' positioning of students in their discussions.

Background

Fennema and colleagues (1996) developed Cognitively Guided Instruction (CGI), a well-

known research program based on the idea that providing teachers with a framework for listening to and understanding children's problem solving strategies and mathematical thinking will promote instruction that meets the needs of all students. The results of their work with teachers "suggest that giving teachers access to research-based knowledge about students' thinking and problem solving can affect teachers' beliefs about learning and instruction, their classroom practices, their knowledge of their students, and most importantly, their students' achievement and beliefs" (Carpenter, Fennema, Peterson, Chiang, & Loef, 1986, p. 530).

Battey and Chan (2010) reported on their efforts to use CGI as a vehicle to challenge teachers' beliefs about their students. They note that teachers often describe students by metanarratives and that these stories position African-American students and other populations as inferior to their White and Asian counterparts, casting them as "other." In this multi-year project, they worked to counteract these metanarratives by drawing teachers' attention to what students can do as opposed to what they cannot do and use this *new* way of talking to re-structure the discourse in their professional development program. Their findings indicated that focusing on student thinking did change teachers' discourse about students, and subsequently, teachers rooted their claims about students in evidence instead of assumptions. Additionally, they found that CGI helped teachers focus on individual students' thinking and caused them to shift from larger notions about the group to which they belong to their individual needs. They posit that these behaviors can help dispel the deficit orientation teachers have towards students (Battey & Chan, 2010).

When analyzing teachers' discourse and participation in a professional development organized around student work, Kazemi and Franke (2004) reported changes in the ways teachers talked about student mathematical thinking. They described teachers' focus early on as emphasizing students' mistakes and being unable to provide detailed explanations on how students completed the problem posed to them. However, overtime, teachers provided more detail regarding their students' mathematical work and highlighted various levels of sophistication in students' mathematics reasoning.

Our work engages teachers by using students' mathematical thinking in the form of LTs. Initial studies of teacher learning of LTs indicate that they support teachers in focusing on the process of students' thinking and provide a framework for making instructional decisions (Edgington, 2012; Wilson, 2009). We build from both Kazemi and Franke's (2004) observation of the changes in teachers' conversations around students' work and the emerging research on teacher learning of LTs to investigate the ways teachers discuss their students as mathematical learners in a professional development setting. We use van Langenhove and Harré's (1999) notion of *stereotyping* to consider the set of representations that teachers use to talk about students in their professional community. That is, when teachers talk about students, they use acceptable social representations that conform to the norms of the group. Such discourse positions teachers and students in a variety of ways. Analyzing teachers' discursive patterns in a professional development setting can clarify the types of representations present within a particular professional community.

Methods

This study is part of a larger design study entitled Learning Trajectory Based Instruction (LTBI) and seeks to examine the themes that emerged in teachers' discussions of students during a yearlong professional development. The research question under investigation is: *How do teachers represent students as learners of mathematics in a professional development setting*

focused on students' LTs? The LTBI project is a multi-year design experiment conducted with elementary school teachers in a professional development setting with the goal of studying teacher learning of students' learning trajectories and an instructional model where LTs provide guidance for teachers' instructional decisions. Design experiments are iterative in nature and provide researchers with a means of studying learning in context. They are used to develop "a class of theories about both the process of learning and the means that are designed to support that learning" and they "entail both 'engineering' particular forms of learning and systematically studying those forms of learning within the context defined by the means of supporting them" (Cobb, Confrey, diSessa, Lehrer, and Schauble, 2003, p. 9).

Early on in our work with teachers, we noted the ways teachers talked about students' successes and failures in their mathematical work, revealing some of the acceptable representations of students as learners available to the group. In particular, teachers often described students as "low" or "high" achievers, attributing students' work to a fixed quality of students' aptitude. We contend that these types of statements position students as learners whose capacity for learning is largely predetermined and beyond their influence.

Context

In our project, we initially define Learning Trajectory-Based Instruction (LTBI) as instruction that situates LTs at the center of teaching practice. In the first cycle of this study, teachers spent 60 hours learning about the equipartitioning learning trajectory (EPLT, Confrey, 2012) and how this trajectory can be used in their instruction. Confrey (2008) defined equipartitioning as the cognitive behaviours that lead to the creation of equal sized groups from a collection, or equal sized pieces from a continuous whole, and which result in fair shares. The EPLT is organized by levels of cognitive proficiency; with the earliest levels addressing the ways students accomplish equipartitioning tasks. Confrey's (2012) definition of equipartitioning requires that three conditions be met; 1) students must create equal-sized groups or pieces, 2) students must create the correct number of groups or pieces, and 3) students must use the entire collection or exhaust the whole. These three criteria are represented in the initial levels of the LT, which address dealing collections and splitting a single whole. In addition to changes in what is shared (e.g., a collection of objects, a rectangle, a circle), the trajectory also addresses sharing for different numbers of recipients. The structure of the trajectory represents the ways that the task parameters affect the difficulty of the task. Other ideas contained in the EPLT proficiency levels are: justifying, naming, qualitative compensation, quantitative compensation, and transitivity (Confrey, 2012).

The first portion of the professional development (30 hours) was conducted in the summer of 2010 with a focus on supporting teachers in learning about the content and structure of the trajectory. To do this, teachers viewed clinical interviews of students as well as videos of whole class instruction that exemplified the various task parameters and proficiency levels found in the EPLT. This learning was ultimately formalized by providing teachers with the LT. During the 2010-2011 school year, teachers participated in monthly meetings where the goal was to consider the trajectory in relation their students and instructional practices. In the fall, the focus of the professional development was assessment, and teachers were asked to assess students' understanding of equipartitioning concepts. The focus of the spring meetings was instruction, and teachers were asked to think about how they could use the EPLT in planning and implementing a lesson in their classroom. The professional development concluded with a two-day follow up session the following summer.

Participants

Our partner school for this study was mid-sized elementary school located in the southeastern United States. The school had approximately 600 students, 35% Caucasian, 29% Hispanic, 25% African American, 7% Asian, and 4% other; 54% of the children qualified for free or reduced lunch. Twenty-two elementary teachers participated in this study. Of these teachers, nineteen were full-time teachers, and the other three served in various instructional support roles. The following grade levels were represented in the project: kindergarten (5 teachers); first grade (4 teachers); second grade (5 teachers); third grade (4 teachers) and; fourth grade (1 teacher). Participation in this study was voluntary, and teachers received a stipend for participation.

Data Sources and Analysis

Data for the study consists of video of all whole group discussions and audio of all small group discussions from the professional development, as well as the research team's field notes. Our initial analysis followed a grounded theory approach (Strauss & Corbin, 1989) in which we used open coding of the field notes to identify ways that teachers represented students as learners of mathematics in their discourse. Eight codes were identified: ability/achievement, age/grade, effort, luck/random, out of school contexts, tasks, teaching, and math. Following the recommendation of DeCuir-Gunby, Marshall, and McCulloch (2011), a codebook was developed to provide names, definitions, and examples to illustrate each code. Five independent coders were trained using the codebook to code the audio and video data with 85% reliability. We used our definitions to code every turn teachers made in all whole group and small group discussions that were about students' mathematics using one or more of the codes defined in the codebook. For the purposes of this paper, we focus on one code, "ability/achievement", to examine themes present in these data and how the presence of the LT affected the ways teachers positioned students as they talked about their achievement or ability. In our codebook, we defined ability/achievement to be "a personal trait of the student, a characteristic that defines the student as a person, a fixed quality that relates teachers' views of students' aptitude in mathematics due to either an innate capacity or previous work."

To facilitate the data analysis, we divided the data into four time periods: Quarter I (the first summer institute—30 hours); Quarter II (the Fall monthly meetings—8 hours); Quarter III (the Spring monthly meetings—10 hours) and; Quarter IV (the second summer institute—12 hours). After data from all sessions were coded, further analysis of the achievement/ability code was conducted by looking across all coded talk turns. Open coding allowed for the creation of sub-themes that emerged within this set of data. In the next section, examples illustrate one of these themes along with examples of the influence of the LT.

Results

While examples of teachers' use of ability/achievement to represent students were present in all four time periods, by the end of the professional development, some teachers appropriated this representation in different ways. From our analysis, we noted several patterns within the data related to this evolution, including the nature of teachers' surprises, the role of language, and task differentiation. For this paper, we present one theme along with evidence of the ways the LT was incorporated into the use of the ability/achievement representation in the professional development community.

The Nature of Teachers' Surprises

One trend related to teachers' reference to ability/achievement was the issue of what teachers found surprising about students. In Quarter I, many of the teachers were surprised when students that they typically considered "low," "struggling," or "weak" in mathematics were successful at

completing a task. Consider the following statement made early on in the professional development. After teachers we asked to reflect on when students' mathematical work surprised them, one teacher (G1) stated:

G1: When kids who seemingly struggle with math in general have something that they get just like that, it is surprising. And you definitely have those moments where you want to run out of the classroom. For whatever reason they didn't get nothing else you said all week and they might can't connect it to nothing else you said, but they got that one.

In this example, G1 used the representation available within the discourse of their school community, which we infer to be that students who "struggle" are not successful. Likewise, some teachers described the opposite of this -- when a "high student" or "gifted student" experienced difficulty with a task. For instance, when discussing her students' work on an assessment, C4 states:

C4: The high kids, I really thought they were going to fly through it, but they didn't... But then like my top kid, he gave some out and counted it and then was like guessing and checking... adding one, looking at it, erasing, and he had no strategy.

As with G1, C4 appropriated a representation that students' ability and/or achievement levels predict students' work on mathematics tasks.

Across the duration of the professional development that focused on supporting teachers in learning the EPLT, some of the teachers' uses of ability/achievement related to "low" and "high" students changed to incorporate language from the EPLT. When asked what teachers learned about their students' understanding of equipartitioning, E3 stated:

E3: I taught some of the lower kids in math. At the beginning of the year I thought... wow we've got our work cut out for us. And one of the first tasks that I had kids do was sharing a region and one of the little girls used parallel cuts and got the right number. Cause a lot of times they often think if you're making four shares, they make four lines. But she knew to make three lines... and so I asked her, "If you wanted to make this many equal parts, what would you do?" And she said, "If it's four equal parts, then I'm gonna make one less cuts." It's just amazing... it totally challenged this preconceived idea and notion I had of what my students could do and couldn't do and had knowledge of.

Here, E3 references the ideas of "parallel cuts" and the misconception relating the number of splits to the number of parts produces from the EPLT when discussing what she found surprising for the "lower kids." In a similar manner, teachers expressing surprise about "higher" students also referenced ideas from the trajectory, in particular the proficiency level concerning the naming of results from equipartitioning. During the same discussion as above, C2 stated:

C2: We split our classes and I took the higher of the kids for math. And the naming... they still don't get that piece for as high as they are, they still don't get it. That piece that says, "What would you call this share?" They come up with crazy things so that is something that I see they still need practice.

In addition to being surprised by "low" or "high" students that deviated from their expectations, teachers also attributed students' success or failure in mathematics to their number sense. Although these examples differ slightly from those presented above, teachers' still expect that students with "low number sense" will have difficulty with or not be able to complete mathematical tasks. In Quarter II, teachers were asked to use an equipartitioning task to assess their students. The 2nd grade teachers had students share a collection of 24 items with different numbers of people. When reporting on one student in her class, D2 expresses her surprise:

D2: His number sense is not high. But when we were doing the sharing activity, he was like “I know how to do this! One for me, one for you, one for me, one for you.” And he said “it could go faster if we did two for me and two for you.” And I was like “God!” Here, *D2* is surprised not only that her student was able to fairly share the objects, but also that he recognized that sharing by two is more efficient than sharing objects one at a time as highlighted in the EPLT. This initial way of representing the student in relation to his number sense was problematic because when teachers initially spoke of students’ number sense, it was addressed as a fixed characteristic of students.

While teachers’ statements from early in the professional development demonstrate that they recognize instances where students differ from the accepted notions of ability and achievement, the statements lack the mathematical specificity useful for building future instruction for either “group” of students. Later as teachers learned about students’ mathematics as represented by the EPLT, their dialogue and the nature of their surprise included language about students’ mathematical thinking and activity that was more productive for their community when thinking about teaching and learning. This suggests teachers’ learning of the trajectory provided additional information for teachers when using this particular representation to talk about students.

Discussion

Our goal for this paper was to provide evidence of the ways teachers’ discourse about students related to ability and achievement changed as they learned about one LT. When teachers position students as “low” or “high” achievers or as having “low number sense”, there exists an implicit idea that students’ ability is beyond the control of the teacher and thus, these statements are not useful for teachers’ to consider their instruction. One conjecture we made during this analysis was that teachers’ use of language that positions students in this way would decrease over time because teachers would come to use the LT to orient their representations of students as learners. While we did not find this to be the case, we did find evidence that teachers began to use the language and ideas from the trajectory in addition to the “low” and “high” labels.

When teachers represent students as a “low student” or as someone with “poor number sense”, they take a deficit approach towards these students by focusing on what they do not have as opposed to what they do have. However, when teachers use the LTs to talk about students, they begin to acknowledge what mathematical knowledge the student brings to instruction and discuss their mathematical successes or failures using language from the LT. Because the trajectory provides teachers with a progression of how students’ thinking develops over time, teachers are able to situate students’ understanding and use the LT as a referent when designing future instruction. The following statement made by a teacher at the conclusion of our professional development speaks to the value of LTs and their usefulness in changing how teachers talk about students:

D2: I think from what we’ve learned... learning is not just a linear thing where we can pigeonhole kids and put them in specific groups, particularly because we know they learn through experiences with their peers and all of those things.

As our analysis of these data continues and through our next cycle of design, we are continuing to examine the ways in which teachers represent students as learners of mathematics. With our current cohort of teachers, we have deliberately challenged their positioning of students from the onset of the professional development as we seek to change the discourse of the community. When discussing their students, we ask teachers to describe what students “can” do

as opposed to what they cannot do and to use evidence to ground their claims. Although we did not eliminate the deficit-oriented language from teachers' discourse in the first cohort and we continue to observe this language with the current cohort, we have caused teachers to think more carefully and purposefully about how they talk about students. van Langenhove and Harré (1999) suggested that instead of attending to individuals holding particular stereotypes, one should attend to the act of *stereotyping* within the discourse of a group and that stereotyping is a speech act that builds upon the "acceptable" social representations held by that community. While contend that LTs can be a useful tool in disrupting what is deemed as "acceptable" in a professional development community, we recognize that LTs are not sufficient in eliminating stereotypes. One conjecture is that the language teacher's use in their professional learning teams, grade level teams, and even at the school level is still acceptable and thus continues to re-surface in our professional development group. Findings from this work indicate that while LTs can cause teachers' to focus on individual students and their mathematical thinking, they are not enough to re-write the metanarratives that teachers hold about groups of students. Therefore, future professional development projects should include learning about LTs with a specific focus on unpacking deficit orientations and equity.

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